ARIZONA DEPARTMENT OF WATER RESOURCES

PHOENIX AMA COMPREHENSIVE HYDROLOGIC MONITORING PLAN

SECOND ANNUAL STATUS REPORT

APRIL, 2004

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SECOND ANNUAL STATUS REPORT

PHOENIX AMA
COMPREHENSIVE HYDROLOGIC MONITORING PLAN
OCTOBER, 2003

PURPOSE

This status report provides the Phoenix AMA staff, the Groundwater Users Advisory Council (GUAC), and the general public with information on the progress made by the Hydrology Division during the second year of the Comprehensive Hydrologic Monitoring Plan for the Phoenix AMA.

This status report discusses the progress made between September 2002 and October 2003. It includes the following:

1. A list of monitoring tasks and accomplishments – 2002-2003.
   - Groundwater elevation data collection to include: a description of newly installed and operating groundwater monitoring sites, a description of proposed transducer site selection criteria and the installation and operation of a Domestic Satellite (DOMSAT) system
   - GPS and gravity data collection
   - Remote sensing and crop typing data collection
   - Total dissolved solids (TDS) and common ion data collection
   - Field database and forms development
   - Stream flow data collection

2. A list of cooperators having joined this project in 2002-2003.
   - Groundwater elevation data collection

3. A description of future work remaining.
   - Groundwater elevation data collection
   - GPS and gravity data collection
   - Remote sensing and crop typing data collection
   - Total dissolved solids (TDS) and common ion data collection
   - Database development
   - Stream flow data collection
   - Annual water budget
   - Internet website development

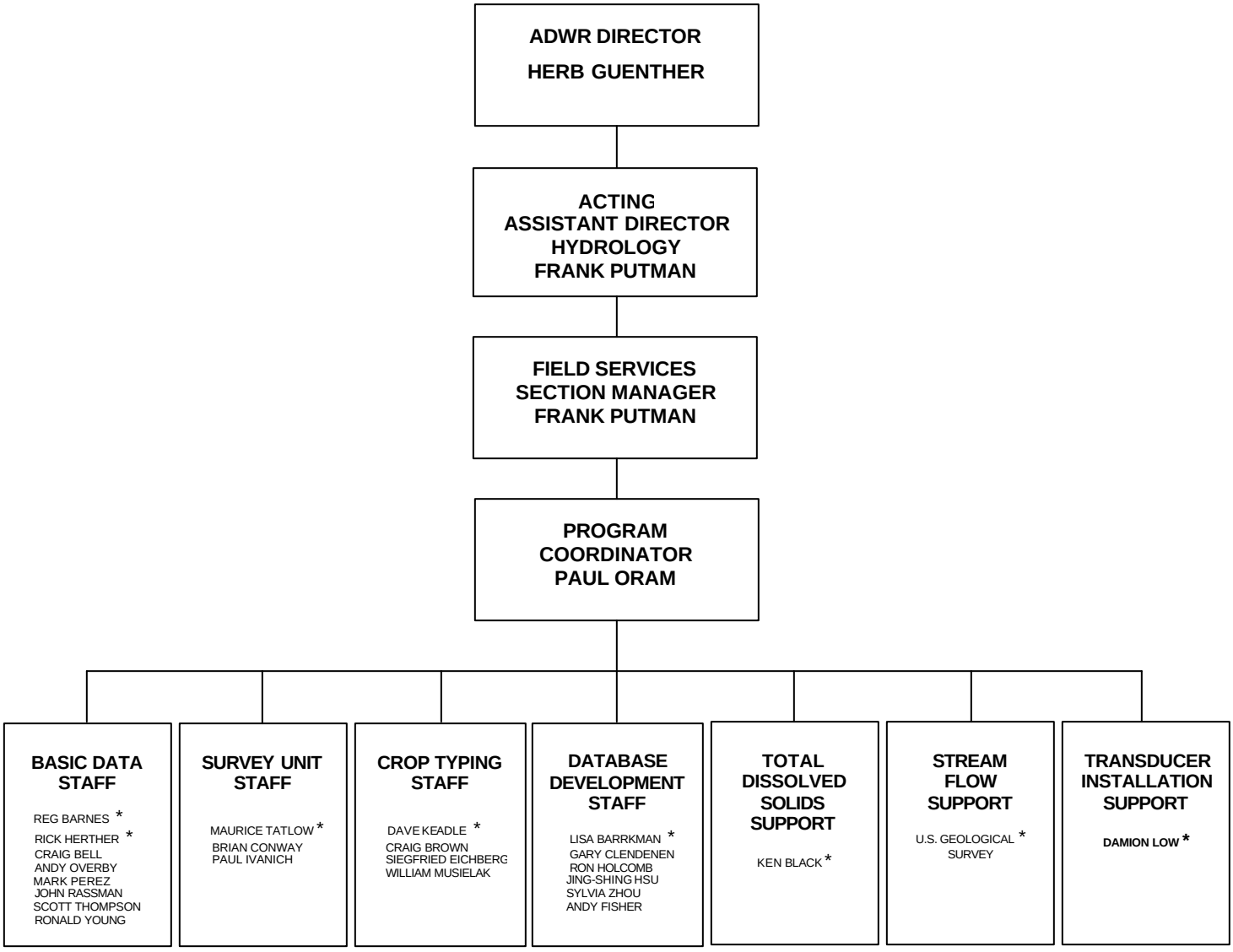
INTRODUCTION

The Arizona Department of Water Resources and its cooperators throughout the state have conducted groundwater-monitoring activities for many years. As part of the dialog with the Governor's Water Management Commission in 2001-2002, it became apparent a need existed for an increased level of monitoring of hydrologic conditions in the Phoenix AMA. Support for monitoring from the commission and funding from the Phoenix AMA Augmentation Fund affords the Department the opportunity to design and implement a comprehensive hydrologic monitoring program.

This program is not limited to the collection of groundwater data alone, as has been the case in the past, but includes the collection of surface water data, subsidence data, gravimetric data and water use data. This will give the department the ability to construct timely and more accurate water budgets, and monitor the hydrologic behavior of the AMA more completely.

The comprehensive monitoring plan was originally designed to be implemented in three phases to allow the installation and monitoring work to be achieved with available staff and funding. The program has just completed its second year. Due to the shortage of available staff the installation phase of the Groundwater elevation data collection task will be accomplished in four years rather than three. At the end of the four years, the system will be in place and maintenance will be an ongoing activity. The experience gained in the Phoenix AMA will be applied to the other AMAs enabling the Department to develop comprehensive monitoring plans in those areas of the state as well.

TASK RESPONSIBILITY CHART



** Indicates Team Leader*

Table 1. Task Responsibility Chart for Phoenix AMA Comprehensive Monitoring Plan

I. LIST OF MONITORING ACTIVITIES 2002 TO 2003

Activities for 2002-2003 (year two) were divided into specific tasks that could be performed by the various teams from the Field Services Section and other staff within the department. These tasks include groundwater elevation data collection, GPS and gravity data collection, remote sensing and crop typing data collection, total dissolved solids (TDS) and common ion data collection, stream flow data collection, database development and internet website development.

TASK ONE

GROUNDWATER ELEVATION DATA FROM TRANSDUCERS, INDEX WELLS, AND NEW MONITORING WELLS

Introduction

Thirty-seven wells have been added to the Phoenix water-level index program in Year Two bringing the total wells measured annually in the Phoenix AMA to 366. This will increase to approximately 400 wells by the fourth year. New monitoring sites will be concentrated in developing areas of the AMA, in areas of high water-level change, where land subsidence is occurring, or in other areas of special interest. Revision of the index well network will include measuring more wells that represent specific aquifer units and the installation and use of up to 70 continuous recording, digital pressure transducers. Each year about 20 transducers will be installed throughout the Phoenix AMA. Most transducer sites will be equipped with Geostationary Operational Environmental Satellite (GOES) data transmitters. Other transducer sites will have the data downloaded manually.

Because of the limited staff and an increasing work load, transducer installation is anticipated to occur in several phases, with each phase taking one year to complete. Experience in the Prescott and Santa Cruz AMAs has shown that 15 to 20 new transducer sites can be installed per year with existing staff.

Twelve transducer sites were installed during Year Two. Other activities included review of current water-level index lines, locate wells, and obtain letters of agreement for transducer sites. Years Three and Four will be similar in scope.

After Year Four the program will consist of maintaining the index lines and transducer sites and replacing faulty transducers systems as needed. Areas

where water level information is critical will be evaluated each year beginning in Year Four and transducer sites may be installed in several of those areas as well.

To date, 20 transducer sites have been installed and are in operation throughout the Phoenix AMA with 12 new sites being added during Year Two. Nineteen of these sites are transmitting data using satellite telemetry (See Figure 1). The remaining site, installed during Year One, is not equipped with satellite telemetry because of concerns about community aesthetics (See Figure 2). These sites were chosen based on several criteria discussed later in this report (See Appendix A, Page 24, and Appendix C, Map Plates 1-13). All transducers are recording date, time, and depth to groundwater, groundwater temperature, and system battery voltages every 6 hours. Some transducers will have the data collected manually and posted to ADWR's Groundwater Site Inventory (GWSI) database manually. Transducer data being transmitted via satellite uses the National Oceanic and Atmospheric Administration (NOAA) Geostationary Operational Environmental Satellite (GOES) System to send the data once per day. The telemetry data is acquired via the Local Readout Ground Station-Domestic Satellite (LRGS-DOMSAT) receiving system installed at the ADWR building in December of 2002. This system gives the Department the ability to receive the satellite transmitted water-level data directly from the field or queried through the (NOAA) Internet or Telnet web sites. The data is captured and uploaded into data tables where both manually downloaded and satellite transmitted data are posted daily. These data are made available to the public on ADWR's Field Services Website at www.water.az.gov/fieldservices.

Figure 1. Typical transducer site configured with satellite telemetry

Figure 2. Typical transducer site with low profile arrangement and no satellite telemetry

Current Groundwater Data Collection Site Characteristics

Table 2 on page 6 briefly describes the installed groundwater data collection sites' characteristics and parameters. Figures 3 through 16 on pages 6 through 10 are images of the 12 sites completed within the Phoenix AMA during the programs second year.

SITE CODE	WELL LOCATION	WELL OWNER	WELL ALTITUDE	WELL DEPTH	SATELLITE TELEMETRY	DATE COMPLETE
AA	D-02-07 22BBC	QUEEN CREEK	1403	606	YES	04/17/2002
AB	A-02-03 09CDA	ROSE LANE SCHOOL	1177	255	YES	04/19/2002
AC	B-04-05 01CBA	DOUGLAS LAND CORP.	1600	1000	YES	05/21/2002
AD	D-04-09 05AAD	BRIAN NICHOLS	1551	900	YES	06/06/2002
AE	A-03-01 04DBB	ARIZ. AMERICAN WATER	1192	910	YES	06/19/2002
AF	A-02-04 01ACC	CITY OF SCOTTSDALE	1298	1800	YES	07/30/2002
AG	A-05-05 05CAA	CITY OF SCOTTSDALE	2680	1505	NO	08/16/2002
AH	A-03-04 11CBA	CITY OF SCOTTSDALE	1448	1200	YES	09/11/2002
AI	A-02-02 28ABB2	CITY OF PHOENIX	1111	630	YES	10/02/2002
AJ	A-03-02 15DDD	CITY OF PHOENIX	1256	1585	YES	10/16/2002
AK	A-04-01 34BDD2	CITY OF PEORIA	1215	938	YES	02/28/2003
AL	A-04-01 14CBB	CITY OF PEORIA	1293	785	YES	03/18/2003
AM	A-01-06 15ACD	CITY OF MESA	1355	1204	YES	04/11/2003
AN	B-02-01 06ABB2	ADAMAN WATER CO.	1128	730	YES	04/20/2003
AO	B-02-02 13ABB	ADAMAN WATER CO.	1099	752	YES	04/23/2003
AP	A-01-05 29DDA	CITY OF MESA	1218	490	YES	05/12/2003
AQ	A-03-02 06DAA	CITY OF GLENDALE	1244	1003	YES	07/25/2003
AR	A-01-05 02DDC1	SALT RIVER PROJECT	1260	700	YES	08/07/2003
AS	C-01-04 06BBA	ROOSEVELT IRR. DIST.	915	1694	YES	09/20/2003
AT	D-01-05 15CDD2	SALT RIVER PROJECT	1218	660	YES	10/22/2003

Table 2. Groundwater-data collection site characteristics

Figure 3. City of Phoenix site AI located on 47th Ave. south of Indian School Rd.

Figure 4. City of Phoenix site AJ located on the NW corner of 35th Ave. and Cactus Rd.

Figure 5. City of Peoria site AK located on 87th Ave. between Bell Rd. and Union Hills Dr.

Figure 6. City of Peoria site AL located on Williams Dr. east of 83rd Ave.

Figure 7. City of Mesa site AM located on Adobe St. between Val Vista Dr. and Greenfield Rd.

Figure 8. Adaman Water Co. site AN located on Alsup Rd. south of Northern Ave.

Figure 9. Adaman Water Co. site AO located on the SE corner of State Rt. 303 and Bethany Home Rd.

Figure 10. Site AO equipment configuration inside the shelter

Figure 11. City of Mesa site AP located on SW corner of Alma School Rd. and Emerald Ave.

Figure 12. City of Glendale site AQ located on SW corner of 59th Ave. and Paradise Ln.

Figure 13. Construction of site AQ in the City of Glendale

Figure 14. SRP site AR on McKellips Rd. Between Mesa and Stapley Drives

Figure 15. RID site AS on Baseline Rd. in the Southwest Valley west of Buckeye, AZ.

Figure 16. SRP site AT on Warner Rd. between Arizona Ave. and McQueen Rd. in Chandler, Az.

Transducer Well Site Selection Process

A Groundwater Site Inventory (GWSI) database query was developed to generate a list of unused and unequipped well sites throughout the Phoenix AMA as potential transducer candidates. Each well site was then visited and inventoried by Basic Data staff. If the well was unused and unequipped it received a database code, which enabled it to be pulled from the database and placed on a Geographic Information System (GIS) map. Each of these potential transducer sites went through a criteria selection process and evaluated as to water-level fluctuations, aquifer penetration, multiple aquifers completion, proximity to known subsidence zones, areas of major land development, proximity to groundwater recharge projects, and proximity to EPA Super Fund and WQARF sites (See Appendix A, Page 25).

A letter of agreement was drafted following the Department of Administration's Risk Management guidelines and sent to the owners of the candidate sites along with an explanation of the monitoring program and a schematic diagram of the transducer site. To further expand the pool of potential transducer sites, the same information was sent to Phoenix AMA municipalities, irrigation districts and water companies. Those entities interested in the project in turn provided a list of candidate wells for ADWR to further evaluate (See Appendix B, Page 27).

(NOAA) GOES Satellite Account Authorization

Most of the transducer sites will be equipped with satellite telemetry. A formal GOES DCS (Data Collection System) Use Agreement between ADWR and NOAA was created through the NOAA NESDIS (National Environmental Satellite Data and Information Service). This contract is valid through January of 2007 and must be renewed every five years.

An initial request was made and filled in the program's first year for twenty DCP (Data Collection Platform) accounts that provide an identification number and time window for transmitting groundwater data through the GOES satellite system. During the second year NOAA approved a request for an additional 50 DCP accounts bringing the total number of NOAA accounts in the Phoenix AMA to 70.

Phoenix AMA Groundwater-Level Measurement Sweep

ADWR's Basic Data staff collected approximately 1900 water levels in a basin-wide sweep of the Phoenix AMA between November 2002 and March 2003. The sweep was performed as part of the Monitoring program's overall effort in the assessment of an annualized groundwater budget and will be used in the upcoming Phoenix AMA Hydrologic Map Series Report.

ADWR Database Development and Interactive Transducer Website

The ADWR Information Technology Division (ITD) created an upload utility that enables field and telemetry transducer data to be quality checked and quickly uploaded to the ADWR Groundwater Site Inventory (GWSI) data tables.

ITD is continuing work on an interactive website that will allow Internet users to query both real-time and historical transducer data within the Phoenix AMA. These data are made available at ADWR Field Services website address: www.water.az.gov/fieldservices/.

TASK TWO

LAND SUBSIDENCE AND AQUIFER STORAGE MONITORING

Introduction

Land subsidence is a well-documented effect of extensive groundwater depletion and has been studied in the Phoenix, Pinal, and Tucson AMAs, as well as many other areas of the United States. Monitoring of specific areas of subsidence through Global Positioning System (GPS) surveys of land elevation changes and gravimetric measurements of changes in water stored in the aquifer may allow the Department to design appropriate management programs to deal with these issues. Potential affects of subsidence include changes in drainage characteristics, infrastructure damage, and loss of aquifer storage capacity. Interferometric Synthetic Aperture Radar (InSAR) is also being used to better map and understand subsidence patterns throughout the Phoenix AMA (See Figure 17, Page 14 and Appendix C, Plate 8).

The Surveying Unit of the Field Services Section of ADWR is performing aquifer storage monitoring (gravity surveys) and land subsidence monitoring (GPS surveys) surveys within the Phoenix AMA.

In addition to performing gravity and GPS surveys the Surveying Unit is partnering with other groups that have interest in monitoring land subsidence, fissure formation and development, and aquifer storage change. These groups include the Flood Control District of Maricopa County, the Maricopa County Department of Transportation (MCDOT), The Central Arizona Project (CAP), the City of Scottsdale, the National Geodetic Survey (NGS), Arizona State University (ASU), and the National Aeronautics and Space Agency (NASA) Center for Space Imaging. Working with these groups allows ADWR to maximize the benefit of its monitoring efforts and minimize costs.

Work and Projects in 2002-2003

Interferometric Synthetic Aperture Radar (InSAR): The Department is continuing to generate InSAR products (interferograms, deformation profiles, and XYZ raster files) within the Phoenix AMA through the 1.3 million dollar NASA BAA grant. A partial list of end users include the Flood Control District of Maricopa County, CAP, City of Peoria, City of Scottsdale, SRP, NRCS, AMEC, Geological Consultants, Arcadis, GeoTrans, HydroGeophysics, and Clear Creek Associates (See Appendix C, Plate 8).

Phoenix AMA Aquifer Storage Monitoring Network: The Unit performed the second set of gravity occupations of aquifer storage monitoring stations from 03/2003 through 05/2003. This included occupations of the three Toyota Test Track stations.

Pool 24 ADWR/CAP/ASU project: This project was completed in 2003. Paul Ivanich of ADWR will finish and publish a M.S. thesis 12/2003. This project led to the discovery of a new earth fissure within a hundred meters of the CAP canal in northeast Scottsdale. Based of initial project results, the CAP has retained consultants Geo Trans and HydroGeophysics to continue an on-going, expanded investigation of this area that includes the CAP Pool 23 and Pool 24 areas.

East Valley CAP project: This project has been completed. Results incorporated into the interpretation of the Hawk Rock subsidence area, as well as being used to ground truth interferogram results.

Hawk Rock GPS survey: The Surveying/GPS Unit performed a Real Time Kinematic (RTK) GPS Survey of the Hawk Rock network in August 2003 using TOPCON GPS equipment supplied by Holman's Surveying Supply Company of Tempe, AZ. This was ADWR's fifth survey of this 33-station network. Results are being used to ground truth interferogram results and will be supplied to all interested parties.

Water Quality Assurance Revolving Fund (WQARF) projects: RTK GPS surveys of specific wells have been completed on the West Central Phoenix and Central Mesa project areas for WQARF support.

ADEQ GPS base station support: Two sets of static GPS surveys were performed for ADEQ at their new building to determine the location of their Differential GPS Base Station.

Field Services Transducer surveys: A static GPS survey has been initiated to provide survey-grade locations for the transducer well sites of this Phoenix AMA Comprehensive Monitoring Program.

Absolute Gravity Surveys: Support is ongoing for NGS absolute gravity measurements at stations PHX AA (in South Mountain Park), PHX AB (in Dreamy Draw Park), PHX AC (Usery Mountain AT&T facility), and CENTRAL ARIZONA COLLEGE.

71st and Olive Avenue Gravity Survey: The Unit established 200 gravity stations in and around the 71st and Olive Avenue land subsidence feature to help determine the root cause of the deformation that is occurring at this location. An ASU graduate student may continue more detailed work and interpretation of these data during 2004.

Gravity and RTK GPS at McMicken Dam: A gravity and RTK GPS survey was performed at the southern end and central portion of McMicken Dam. These data, in conjunction with ADWR's InSAR data, were used by the Maricopa County Flood Control District to determine the best solution for repairing and monitoring this flood control structure.

Gravity and RTK GPS at Whitetanks FRS #3: A gravity and RTK GPS survey was performed at the northern end of the Whitetanks Flood Retention Structure #3. These data in conjunction with ADWR's InSAR data were used by the Maricopa County Flood Control District to determine the best solution for repairing or removing this flood control structure.

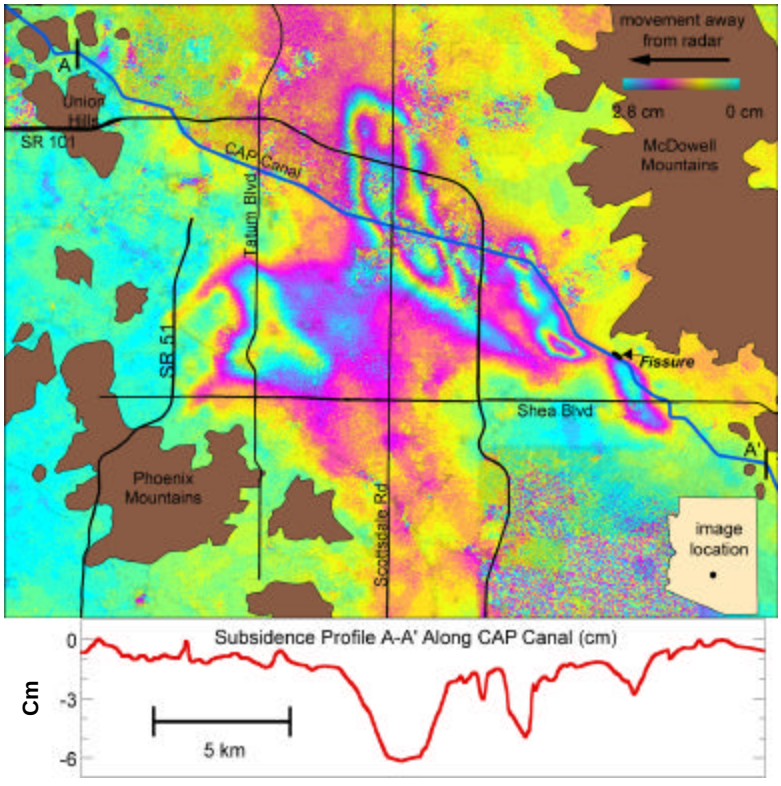


Figure 17. 1,085 day (12/30/96 – 12/20/99) interferogram and deformation profile along CAP canal in central Arizona.

TASK THREE

CROP TYPE AND ACREAGE DETERMINATION

Introduction

A remote sensing program has been implemented to facilitate the acquisition of agricultural data to allow more accurate estimates of water use and recharge. In the Phoenix AMA, the acquired data includes the number of acres in agricultural production and the type of crops grown. The data will eventually aid in analyzing agricultural water use and recharge in order to improve the accuracy of the AMA's water budget.

Work and Projects Ongoing in 2002-2003

ADWR is currently working with remote sensing specialists from the US Bureau of Reclamation to implement the Lower Colorado River Accounting System (LCRAS) methodology in the Phoenix AMA.

High-resolution color satellite imagery was obtained to delineate agricultural fields and boundaries. The fields were digitized, given unique identification numbers, and stored in a database. Landsat 5 and Landsat 7 satellite images were used to discriminate between crop groups and agricultural land use. This process utilizes ERDAS's IMAGINE® software in classifying crops using the reflective value of each digital pixel, or signature.

Part of the process involves field verifying approximately 15 percent of the agricultural fields in the AMA. The field verification or ground truthing is scheduled in conjunction with satellite passes. The ground reference data is used in the image classification process to improve accuracy. Optimally, imagery processing and ground truthing will take place two to three times per year in order to capture the seasonal variation of all agricultural land use. The seasonal timing of each analysis is dependant on the nature of crops grown in the AMA. Plate 13 of Appendix C shows fields that were visited for ground truthing purposes.

Table 3 on page 16 shows a listing of crop types and corresponding acreages accessed at various times throughout the year using both satellite imagery and ground truthing. The data will be utilized in determining new water budgets and updating hydrologic models.

CROP TYPE	OCTOBER 2002 ACRES[1]	PERCENTAGE OF TOTAL ACRES	APRIL 2003 ACRES	PERCENTAGE OF TOTAL ACRES	JUNE 2003 ACRES	PERCENTAGE OF TOTAL ACRES
ALFALFA	45,381	21%	74,485	33%	67,698	34%
BERMUDA GRASS	N/A	N/A	N/A	N/A	339	<1%
CITRUS	425	<1%	913	<1%	2,651	<1%
CORN	227	<1%	N/A	N/A	7,298	4%
COTTON	23,311	11%	N/A	N/A	24,471	12%
DATES	18	<1%	N/A	N/A	100	<1%
DECIDUOUS ORCHARDS	89	<1%	223	<1%	618	<1%
FALLOW	138,568	66%	128,628	57%	98,074	48%
GRAPES	N/A	N/A	N/A	N/A	141	<1%
ROSES	N/A	N/A	N/A	N/A	368	<1%
SMALL GRAINS	N/A	N/A	21,098	9%	N/A	N/A
SUDAN GRASS	N/A	N/A	N/A	N/A	257	<1%
TOTAL IRRIGATED ACREAGE [2]	208,019	100%	225,347	100%	202,015	100%
TOTAL NUMBER OF FIELDS	6,671		6,250		5,988	
ACREAGE SAMPLED [3]	30,566		29,716		38,557	
TOTAL DATABASE ACRES [2]	231,280		225,947		222,799	
OVERALL ACCURACY	93%		92%		95%	

NOTES:

1. **For the October survey ADWR only purchased one satellite image, therefore a few fields in the east valley did not get classified because they did not fall within the extent of the image.**

2. **Total Database Acres is the acreage within the ADWR field boundary database originally developed from satellite images. When field surveys take place some of the Total Database Acres are found to be developed or to consist of native vegetation, non-irrigated pasture, or non-agriculture uses, or to have other uses such as greehouses, which are not considered to be irrigated agriculture. These uses are subtracted from the Total Database Acreage to give Total Irrigated Acreage. The Totals have trended downward because of urban development.**

3. **Field staff visited 15% of the fields to verify crop type. A small number of fields from the 15% field survey were not used because they were found to be developed or to consist of native vegetation, non-Ag pasture, greenhouses or unknown use.**

Table 3. Crop types and acreages of fields accessed October 2002 - June 2003

TASK FOUR

WATER QUALITY MONITORING

Introduction

ADWR has broad water-quality concerns related to the suitability of water for various use sectors. There have been concerns expressed that importation, use and subsequent recharge of CAP water may add to the accumulated salt load in the aquifer over time. This is one example of how the overall quality of water may affect its utilization.

The USGS and ADWR have collected thousands of specific conductance samples over the years, and this approach has been expanded to allow a broad view of water-quality conditions by very inexpensive means. Specific conductance is a field measurement that is closely related to the total dissolved solids (TDS) content of water.

TDS is a broad measurement of the salt load of water. The Department also currently collects basic information on groundwater quality on a regional scale from the water quality index wells. About 50 wells will be randomly sampled for specific conductance per year over the entire AMA and occasional sampling of the flows in the Salt and Gila Rivers will be conducted to monitor TDS levels in the groundwater and surface waters of the AMA.

Work and Projects Performed in 2002-2003

The GWSI database was queried to determine which wells were sampled in previous USGS and ADWR groundwater studies. These previously sampled wells were targeted first to provide chronological water-quality data. Wells with close proximity to recharge projects, CAP recharge areas, or large groundwater irrigators within the Phoenix AMA were also sampled.

An annual TDS index line is being established to collect water-quality data within the Phoenix AMA. Fifty-two wells were sampled during 2002, the first year of the project (See Table 4, Page 18 and Appendix C, Plate 12). Due to Department manpower shortages no wells were sampled for TDS during the second year 2002-2003, however, water providers were contacted to determine what existing TDS data they have available and their data is being analyzed to determine where additional wells may be sampled. This new TDS data will be incorporated into ADWR's GWSI database.

LOCAL ID	WATER USE	DATE SAMPLED	SP. COND µS/Cm	TDS * Mg/L
A-01-02 16DBB2	IRRIGATION	8/27/2002	1540	924
A-01-05 03ACC	INDUSTRIAL	7/31/2002	1225	735
A-01-05 30DCD2	IRRIGATION	9/3/2002	1547	928
A-01-06 35ABA	IRRIGATION	7/17/2002	2520	1512
A-02-01 04CBB2	IRRIGATION	8/8/2002	1252	751
A-02-01 20BBB	IRRIGATION	8/8/2002	1150	690
A-02-06 33CAB	IRRIGATION	8/7/2002	1013	608
A-02-06 33CAD2	IRRIGATION	8/7/2002	1062	637
A-02-06 33DCC	IRRIGATION	8/7/2002	1366	820
A-03-01 25ABB	PUBLIC SUPPLY	9/5/2002	457	274
A-03-04 23DAD	IRRIGATION	8/1/2002	385	231
A-03-04 26CCC	IRRIGATION	8/1/2002	469	281
A-03-05 18DCB	DOMESTIC	8/1/2002	391	235
A-03-06 23DCB2	PUBLIC SUPPLY	8/7/2002	425	255
A-04-01 32BAB	IRRIGATION	8/2/2002	409	245
A-04-01 33ACC	IRRIGATION	8/2/2002	485	291
A-06-02 33ABC	INSTITUTIONAL	7/11/2002	400	240
A-06-05 31CDD	DOMESTIC	7/24/2002	456	274
B-01-01 02DBB	IRRIGATION	7/25/2002	1476	886
B-01-01 20DAC	IRRIGATION	7/25/2002	4620	2772
B-01-01 24DDA2	IRRIGATION	8/27/2002	3170	1902
B-01-02 16BBB	IRRIGATION	8/23/2002	2680	1608
B-01-04 32BBB2	IRRIGATION	8/6/2002	400	240
B-02-01 01CCC2	INDUSTRIAL	8/8/2002	589	353
B-02-01 14AAD	IRRIGATION	8/8/2002	577	346
B-02-02 24BBB3	IRRIGATION	8/28/2002	1031	619
B-02-06 09BBA	IRRIGATION	8/6/2002	3270	1962
B-02-07 36CBB	IRRIGATION	8/6/2002	1432	859
B-03-01 15CBB3	IRRIGATION	8/5/2002	541	325
B-03-01 16BCC	IRRIGATION	8/5/2002	676	406
B-03-01 16DBB2	IRRIGATION	8/5/2002	934	560
B-03-01 16DBB3	IRRIGATION	8/5/2002	666	400
B-03-02 23BAA	IRRIGATION	8/25/2002	406	244
B-04-01 30ABB	IRRIGATION	8/30/2002	536	322
B-05-02 19DDD	DOMESTIC	8/29/2002	389	233
B-05-02 24BAB	DOMESTIC	9/5/2002	1097	658
B-05-02 25CCC2	PUBLIC SUPPLY	9/5/2002	371	223
C-01-03 05AAB	IRRIGATION	8/27/2002	5110	3066
C-01-05 13AAB	IRRIGATION	8/6/2002	5490	3294
C-02-01 30DDD	IRRIGATION	8/22/2002	1785	1071
D-01-02 06DDD	IRRIGATION	8/27/2002	2860	1716
D-01-04 11BCC	IRRIGATION	9/3/2002	1834	1100
D-01-05 11CCC	DOMESTIC	7/30/2002	2330	1398
D-01-06 03CAB	IRRIGATION	9/3/2002	2000	1200
D-01-06 18CAB	PUBLIC SUPPLY	9/3/2002	1740	1044
D-01-08 06DBC	INDUSTRIAL	7/31/2002	1622	973
D-02-05 04DDA	IRRIGATION	9/3/2002	2140	1284
D-02-05 06ACD	DOMESTIC	7/22/2002	2070	1242
D-02-05 29AAA	IRRIGATION	7/26/2002	4350	2610
D-02-06 13DDA	IRRIGATION	7/31/2002	2160	1296
D-02-06 20DAD	DOMESTIC	7/26/2002	1551	931
D-02-06 25DDD	IRRIGATION	7/31/2002	1983	1190

NOTE: The Total Dissolved Solids (TDS) level is only an approximation. A general conversion factor of 0.6 was used to convert specific conductance values from microSiemens per centimeter (µS/Cm) to TDS levels in milligrams per liter (mg/L). The actual conversion factor will vary depending on the water quality specific to each well.

Table 4. Specific Conductance and TDS values from wells sampled in 2002

TASK FIVE

GWSI FIELD DATABASE AND FORMS DEVELOPMENT

A crucial part of the monitoring program is the ability to interact with the Department's groundwater database and manipulate data while in the field. The Information Technology Division (ITD) and Hydrology Division are involved in a combined effort to design and implement a field-interactive database application allowing Field Services personnel to enter field-collected data directly into the Department's Groundwater Site Inventory (GWSI) database. The new application has eliminated the need for transcribing data from field forms to coding sheets before the data is input into the GWSI. The new system has effectively cut two steps out of the transcription process greatly reducing errors and office time associated with transcribing data. This new field data input system was implemented during the winter of 2002-2003. The system also allows the incorporation of GPS data and digitized maps for navigation and well locating.

TASK SIX

STREAM FLOW RECHARGE

The US Geological Survey (USGS) was enlisted under the ADWR/USGS cooperative agreement to construct and operate new stream-gaging stations in the Phoenix AMA. After conferring with the USGS, it was determined that two stations would be constructed and placed into operation during the plan's first year (See Appendix C, Plate 5). These two new stations will help bolster the more than 100 stream-gaging stations already in place within the Phoenix AMA. The Maricopa County Flood Control District and the USGS operate these gage sites in cooperation with ADWR, Salt River Project (SRP) and other agencies.

The two stream-gaging stations have been completed and are currently in operation. One stream-gage is located at the 51st Ave. bridge crossing on the Salt River in Phoenix (See Figure 18, Page 20). The USGS identifying number is 09512406 and real-time data for this site can be found at the USGS Internet web address http://waterdata.usgs.gov/az/nwis/uv?09512406. The second site is located at the Attaway Rd. bridge crossing on the Gila River in Pinal county just south of the Phoenix AMA (See Figure 19, Page 20). The USGS identifying number for this site is 09477570 and real-time data can be found at the USGS Internet web address http://waterdata.usgs.gov/az/nwis/uv?09477570. The two stations are equipped with pressure transducers and data loggers to record data and are radio equipped for real-time data transmission using the GOES domestic satellite transmission system.

Figure 18. USGS/ADWR stream-gage #09512406 at 51st Ave and the Salt River

Figure 19. USGS/ADWR stream-gage #09477570 at Attaway Rd. and the Gila River

II. FUTURE WORK AND PLANNING

Groundwater-Level Data Collection

- Install about 15 pressure transducers in wells per year. ADWR will continue to install pressure transducers for groundwater data collection systems throughout the Phoenix AMA using the current well selection criteria outlined in Appendix A.
- Continue to locate critical areas within the Phoenix AMA where groundwater data collection is essential but no existing well sites are available. These locations will become candidate monitoring well installation sites.
- Investigate and locate new transducer well site candidates throughout the Phoenix AMA and solicit participation from new entities and acquire signed letters of agreement for transducer installation.
- Continue to operate and maintain current transducer well sites. Continue to periodically download field data from transducer sites and input into ADWR's Groundwater Site Inventory database.
- Add about fifty wells to bolster the Phoenix AMA water-level index lines throughout all three phases of the monitoring program bringing the total number of water-level index wells to around 400. There are currently 366 water-level index wells in nine books throughout the Phoenix AMA. About 15 new wells will be added to the water-level index program annually. These wells will be measured annually and the data entered into the GWSI database. The existing index wells/books will be evaluated and refurbished

as needed. Wells that have been abandoned or the well access impaired will be replaced.

- Prepare a Phoenix AMA, Hydrologic Map Series Report (HMS) in conjunction with the Phoenix AMA basin wide water-level sweep that was completed during the winter of 2002-2003. The HMS report will be produced in digital CD format and made available to the public at the ADWR bookstore in 2004. This report will include a map displaying well points with corresponding water levels and water-level elevation values along with water-level elevation contours and groundwater flow direction arrows. A second map will show water-level changes in wells measured in 1997 and again in 2002. The Phoenix AMA HMS will also include water-level hydrographs illustrating historic water-level changes.

GPS/GRAVITY Projects

- Phoenix AMA Aquifer Monitoring Network: The GPS/Gravity group plans to perform the third set of gravity occupations in January and February of 2004 along with static GPS surveys at selected stations.
- Pool 24 ADWR/CAP/ASU project: Based on initial project results, CAP has retained consultants GEOTrans and HydroGeophysics to continue an on-going, expanded investigation of this area in 2004 that includes the CAP Pool 23 and Pool 24 areas. ADWR continues to support this investigation by generating new interferograms of the area and providing these products to all interested parties as well as helping with the GPS monitoring.
- Hawk Rock GPS survey: ADWR's GPS/Gravity group will perform a survey on the 33-station network again in 2004.
- Field Services Transducer surveys: GPS surveys to provide the Department with survey-grade locations for the Phoenix AMA transducer site installs will continue in 2004 as these sites become available
- Absolute Gravity Surveys: ADWR will continue to support NGS absolute gravity measurements at stations PHX AA (South Mountain Park), PHX B (Dreamy Draw Park), PHX AC (Usery Mountain AT&T facility), and Central Arizona College.
- 71st and Olive Avenue Gravity Survey: An ASU graduate student may continue more detailed work and interpretation in 2004 of data to date. This may involve additional gravity and BPS surveys.
- Interferometric Synthetic Aperture Radar (InSAR): ADWR will continue the InSAR project in 2004 and will involve ground truthing with GPS surveys. The Department will continue to generate InSAR products such as interferograms, deformation profiles, and XYZ raster files within the Phoenix AMA through the NASA BAA grant.
- Hassayampa Gravity and GPS Surveys: The Field Services' GPS/Gravity Unit will perform both gravity and GPS surveys in support of the Department's groundwater modeling effort in the Phoenix AMA's Lower Hassayampa Sub-basin. This will involve performing relative gravity surveys throughout the sub-basin for the purpose of depth-to-bedrock interpretations as well as more

clearly defining the shallow subsurface lithology. GPS surveys will be required to establish the location and elevation of all stations used in the gravity survey.

Remote Sensing and Crop-Typing

- LandSat image processing and ground truthing will take place in February, March, and June in 2004 in order to capture seasonal crop variations and to determine when agricultural land goes in and out of production. Again this year approximately 15% of the AMA total agricultural acreage will be field verified and a summary of the Phoenix AMA's cropped acreage will appear in next year's Monitoring Program Status Report.

Water Quality Monitoring and Collection

- ADWR's Field Services staff will collect approximately 50 new Total Dissolved Solids (TDS) samples and continue to contact water providers to obtain their TDS data when available in the continuing effort to build an annual TDS index line. After the three-year setup phase the Department will have sampled enough wells to determine in which areas of the AMA wells should be sampled annually. The creation of this yearly TDS monitoring line will help determine the affect that salt loading has on how the AMA's groundwater is utilized.

Stream Flow Data Collection

- ADWR in cooperation with the USGS will continue to monitor the data from the two new stream gages installed on the Salt and Gila Rivers in 2002. In addition ADWR will utilize this data along with that of other stream gages throughout the Phoenix AMA to help formulate a more accurate water budget.

Database Development

- The Hydrology Division and the Information Technology Division (ITD) staff will continue the combined effort to field test and improve the field-interactive database utility that was completed and implemented in 2002. They have also created an ADWR Field Services website dedicated to providing historic water-level data from the numerous pressure transducers installed in wells throughout the state.

Annual Status Report

- ADWR will continue to produce a comprehensive and detailed 3rd Annual Status Report using the data collected and evaluated during the third year of this monitoring plan. These data will be used by the Hydrology Division to produce more accurate and more complete annualized water budgets for the Phoenix AMA.

APPENDIX A

DESCRIPTION OF TRANSDUCER SELECTION CRITERIA

DESCRIPTION OF TRANSDUCER SITE SELECTION CRITERIA

The Phoenix AMA transducer locations are based on a set of criteria to achieve the best overall spatial coverage in two- and three-dimensional parameters, and in key groundwater areas throughout the AMA. The criteria are as follows:

1. Well casing perforated in upper, middle or lower aquifer units (See Appendix C, Plates 2, 3, & 4)
2. Proximity to a major stream channels (See Appendix C, Plate 5)
3. Large water-level changes occurring within a five year period (See Appendix C, Plate 6)
4. Municipalities which have provided transducer candidate sites (See Appendix C, Plate 7)
5. Proximity to a known subsidence zone (See Appendix C, Plate 8)
6. Proximity to a recharge project or recharge zone (See Appendix C, Plate 9)
7. Irrigation companies which have provided transducer candidate sites (See Appendix C, Plate 10)
8. Proximity to EPA Superfund or WQARF sites (See Appendix C, Plate 11)
9. Areas of anticipated development or urbanization

SITE	PERFORATED IN UPPER AQUIFER	PERFORATED IN MIDDLE AQUIFER	PERFORATED IN LOWER AQUIFER	CLOSE TO WATER COURSES	WATER LEVEL CHANGE LAST 5 YEARS	WITHIN A MUNICI-PALITY	WITHIN OR NEAR A SUBSIDENCE ZONE	NEAR A RECHARGE AREA	WITHIN AN IRR. DISTRICT	WITHIN OF NEAR A WQARF SITE	WITHIN OR NEAR A SUPER FUND SITE
AA	YES	YES	NO	YES	UP	YES	NO	YES	YES	NO	NEAR
AB	YES	NO	NO	YES	UP	YES	NO	YES	YES	NO	NEAR
AC	NO	YES	NO	NO	UP	NO	NO	NO	NO	NO	NO
AD	UNKNOWN	UNKNOWN	UNKNOWN	NO	UP	NO	NO	NO	YES	NO	NO
AE	YES	YES	NO	YES	DOWN	YES	WITHIN	YES	NO	NO	NO
AF	NO	NO	YES	YES	DOWN	YES	NEAR	YES	NO	NO	NEAR
AG	NO	NO	YES	NO	DOWN	YES	NO	YES	NO	NO	NO
AH	YES	YES	YES	NO	UP	YES	WITHIN	YES	NO	NO	NO
AI	YES	YES	NO	NO	DOWN	YES	NO	NO	YES	YES	NEAR
AJ	YES	YES	YES	YES	UP	YES	NEAR	NO	NO	NO	NO
AK	YES	YES	NO	YES	DOWN	YES	YES	YES	NO	NO	NO
AL	NO	NO	YES	YES	DOWN	YES	NEAR	YES	NO	NO	NO
AM	NO	YES	YES	NO	UP	YES	NO	YES	NO	NO	NO
AN	YES	YES	NO	NO	DOWN	NO	NEAR	NO	YES	NEAR	NEAR
AO	YES	YES	NO	NO	UP	NO	NEAR	NO	YES	YES	NEAR
AP	YES	YES	NO	YES	DOWN	YES	NO	YES	YES	NEAR	NEAR
AQ	UNKNOWN	UNKNOWN	UNKNOWN	YES	UP	YES	NEAR	NO	NO	NO	NO
AR	YES	YES	NO	YES	UP	YES	NO	YES	YES	NO	NO
AS	NO	YES	YES	YES	DOWN	NO	NO	NO	YES	NEAR	NEAR
AT	YES	YES	NO	NO	DOWN	YES	NO	YES	YES	NEAR	NEAR

Table 5. Current Transducer Sites with Applicable Selection Criteria
See Appendix C for Map Plates showing Transducer Site Placement

APPENDIX B

PHOENIX AMA MONITORING PLAN COOPERATORS

COOPERATORS IN ADWR'S GROUNDWATER ELEVATION DATA COLLECTION TASK

The following is a list of participants that have signed ADWR's letter of agreement for joint-use of their well site(s) for the purpose of installing transducer, data logger, and telemetry equipment, for water level monitoring.

Cooperator	Date Signed
1. Arizona-American Water Company	March 18, 2002
2. Queen Creek Water Company	March 27, 2002
3. Rose Lane Elementary School	April 8, 2002
4. Douglas Land Corp. L.L.C.	April 22, 2002
5. Brian Nichols	May 5, 2002
6. City of Scottsdale	May 17, 2002
7. Gary Bulechek	May 20, 2002
8. City of Tempe	August 9, 2002
9. City of Phoenix	August 29, 2002
10. City of Peoria	December 2, 2002
11. City of Mesa	March 20, 2003
12. Adaman Water Company	April 1, 2003
13. Salt River Project	June 3, 2003
14. City of Glendale	June 17, 2003
15. Roosevelt Irrigation Company	June 30, 2003

Other well owners will be contacted and added to the above list during the course of the project.

APPENDIX C

MAP PLATES SHOWING TRANSDUCER SELECTION CRITERIA

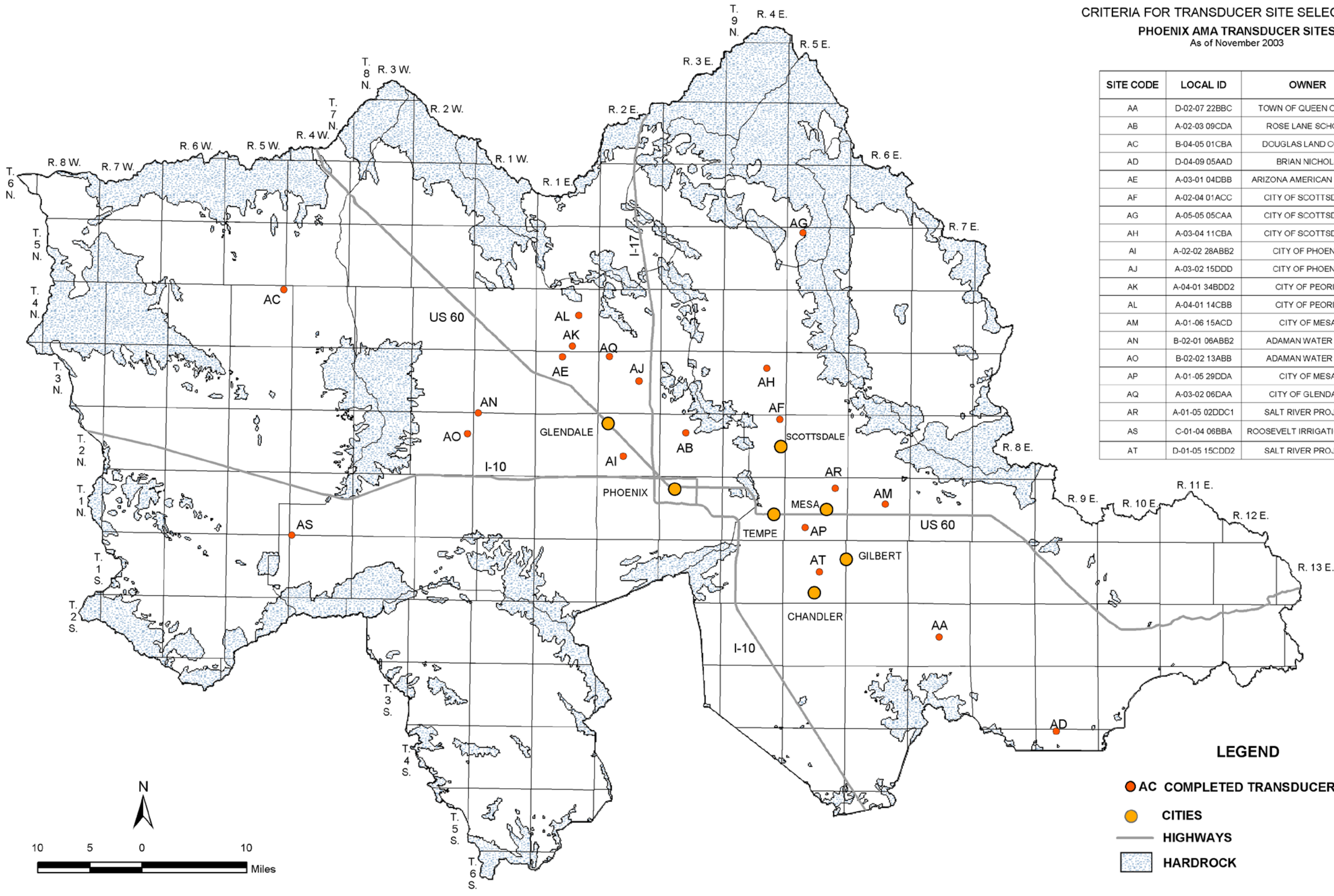
PLATE 1

CRITERIA FOR TRANSDUCER SITE SELECTION

PHOENIX AMA TRANSDUCER SITES

As of November 2003

SITE CODE	LOCAL ID	OWNER
AA	D-02-07 22BBC	TOWN OF QUEEN CREEK
AB	A-02-03 09CDA	ROSE LANE SCHOOL
AC	B-04-05 01CBA	DOUGLAS LAND CORP.
AD	D-04-09 05AAD	BRIAN NICHOLS
AE	A-03-01 04DBB	ARIZONA AMERICAN WATER
AF	A-02-04 01ACC	CITY OF SCOTTSDALE
AG	A-05-05 05CAA	CITY OF SCOTTSDALE
AH	A-03-04 11CBA	CITY OF SCOTTSDALE
AI	A-02-02 28ABB2	CITY OF PHOENIX
AJ	A-03-02 15DDD	CITY OF PHOENIX
AK	A-04-01 34BDD2	CITY OF PEORIA
AL	A-04-01 14CBB	CITY OF PEORIA
AM	A-01-06 15ACD	CITY OF MESA
AN	B-02-01 06ABB2	ADAMAN WATER CO.
AO	B-02-02 13ABB	ADAMAN WATER CO.
AP	A-01-05 29DDA	CITY OF MESA
AQ	A-03-02 06DAA	CITY OF GLENDALE
AR	A-01-05 02DDC1	SALT RIVER PROJECT
AS	C-01-04 06BBA	ROOSEVELT IRRIGATION DIST.
AT	D-01-05 15CDD2	SALT RIVER PROJECT



MAP OF PHOENIX AMA ILLUSTRATING COMPLETED TRANSDUCERS SITES

PLATE 2

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AC COMPLETED TRANSDUCER SITE
- 150 AQUIFER THICKNESS IN FEET (From ADWR Phoenix AMA Moldeling Reports # 6 and # 8)
- CITIES
- HIGHWAYS
- HARDROCK

T. 9 N. R. 4 E. R. 5 E. R. 3 E. R. 2 E. R. 6 E. R. 7 E. R. 8 E. R. 9 E. R. 10 E. R. 11 E. R. 12 E. R. 13 E.
T. 8 N. R. 3 W. R. 2 W. R. 1 W. R. 1 E.
T. 7 N. R. 4 W.
T. 6 N. R. 8 W. R. 7 W. R. 6 W. R. 5 W.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
T. 3 S.
T. 4 S.
T. 5 S.
T. 6 S.

AC AD AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR AS AT AA AB

GLENDALE PHOENIX SCOTTSDALE TEMPE MESA GILBERT CHANDLER

US 60 I-10 I 17

N

10 5 0 10 Miles

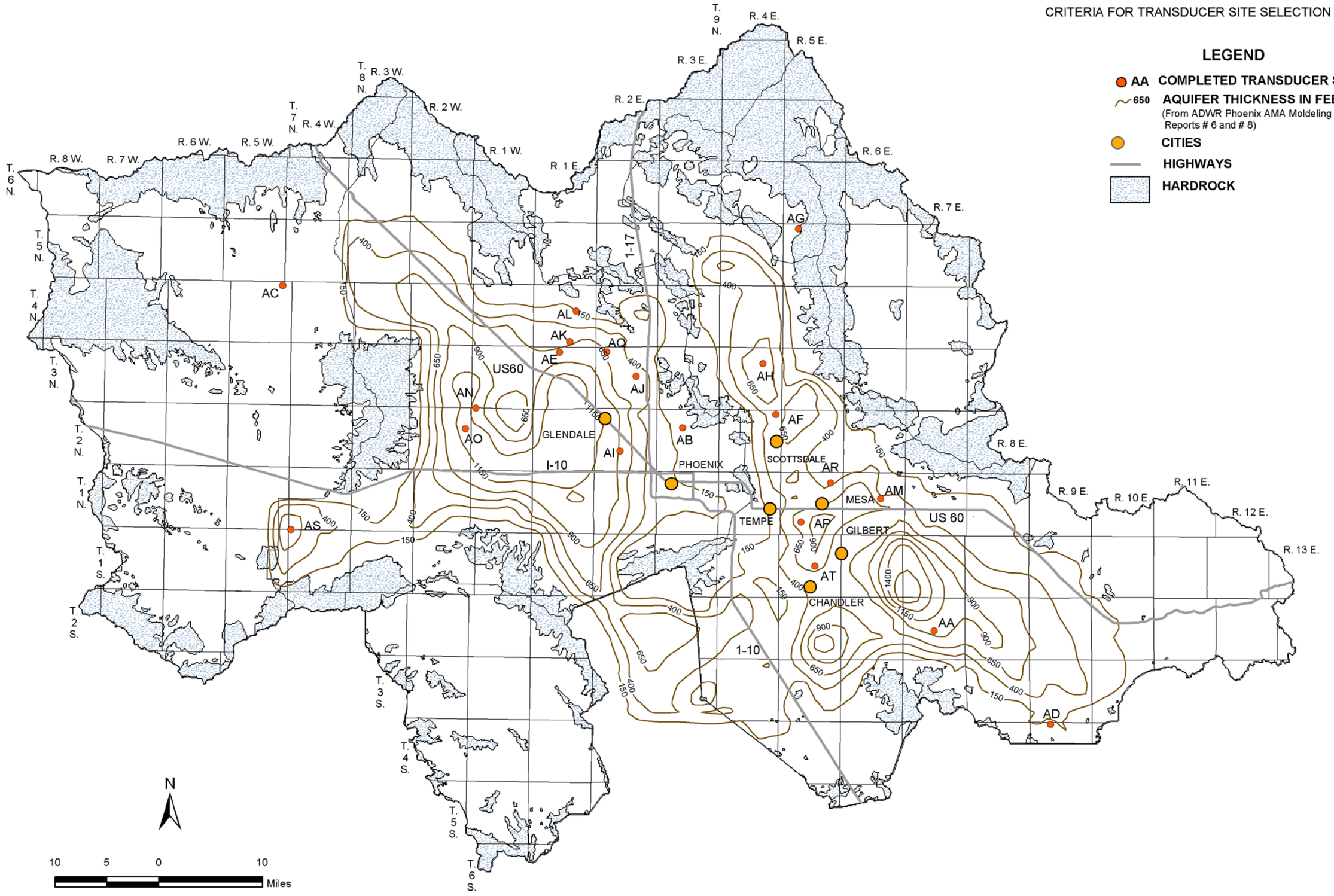
MAP OF PHOENIX AMA ILLUSTRATING UPPER AQUIFER THICKNESS IN FEET

PLATE 3

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AA COMPLETED TRANSDUCER SITE
- 650 AQUIFER THICKNESS IN FEET (From ADWR Phoenix AMA Moldeling Reports # 6 and # 8)
- CITIES
- HIGHWAYS
- HARDROCK

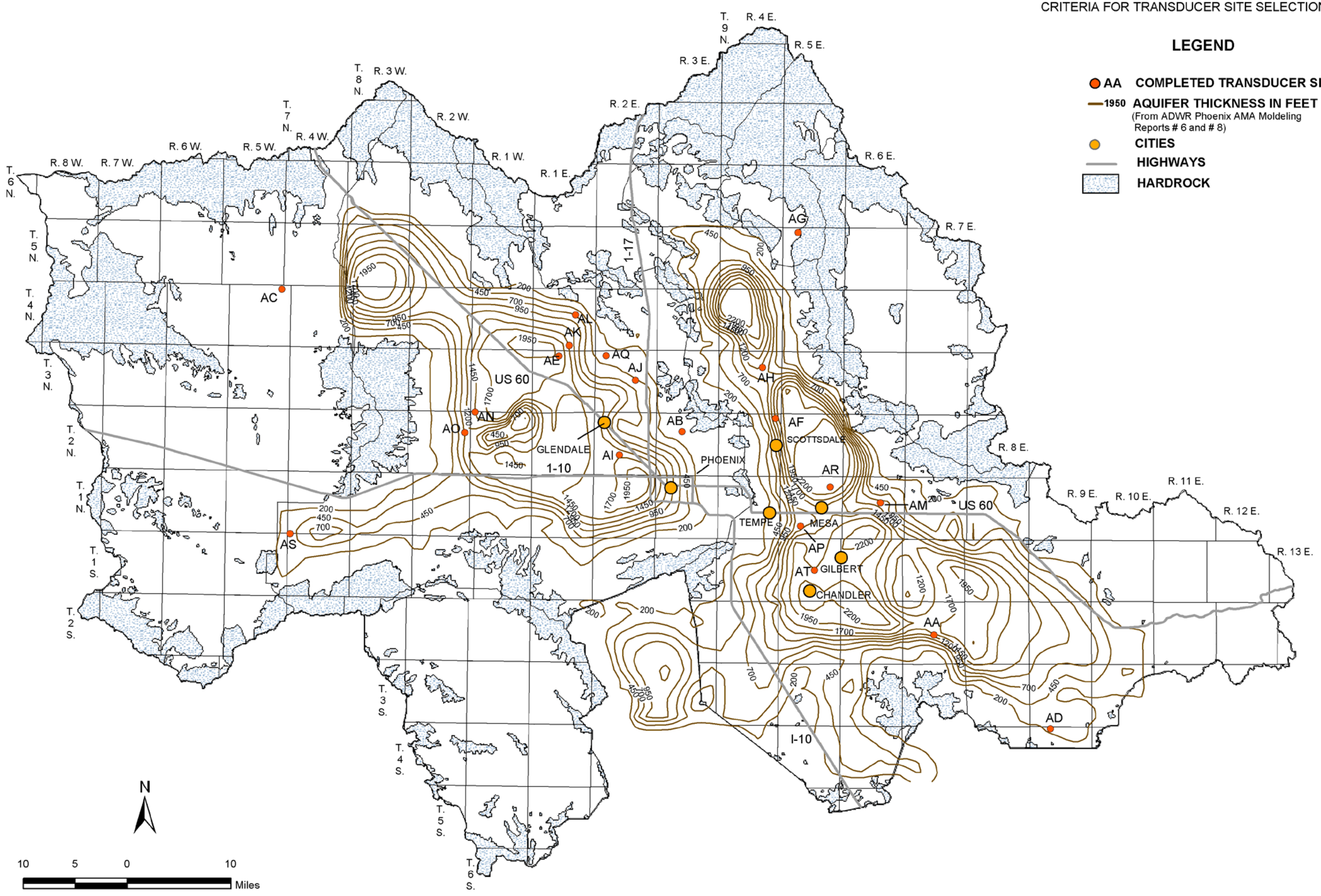


MAP OF PHOENIX AMA ILLUSTRATING MIDDLE AQUIFER THICKNESS IN FEET

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AA COMPLETED TRANSDUCER SITE
- 1950 AQUIFER THICKNESS IN FEET (From ADWR Phoenix AMA Moldeling Reports # 6 and # 8)
- CITIES
- HIGHWAYS
- HARDROCK



MAP OF PHOENIX AMA ILLUSTRATING LOWER AQUIFER THICKNESS IN FEET

PLATE 5

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AC COMPLETED TRANSDUCER SITE
- USGS/ADWR STREAM GAGING STATION
- CITIES
- RIVER AND STREAM
- HIGHWAYS
- HARDROCK

T. 9 N. T. 8 N. T. 7 N. T. 6 N. T. 5 N. T. 4 N. T. 3 N. T. 2 N. T. 1 N. T. 1 S. T. 2 S. T. 3 S. T. 4 S. T. 5 S. T. 6 S.

R. 8 W. R. 7 W. R. 6 W. R. 5 W. R. 4 W. R. 3 W. R. 2 W. R. 1 W. R. 1 E. R. 2 E. R. 3 E. R. 4 E. R. 5 E. R. 6 E. R. 7 E. R. 8 E. R. 9 E. R. 10 E. R. 11 E. R. 12 E. R. 13 E.

STAR WASH
JACKRABBIT WASH
HASSAYAMPA RIVER
BEARDSLEY CANAL
AGUA FRIA RIVER
NEW RIVER
CAMP CREEK
VERDE RIVER
SYCAMORE CREEK
WINTER'S WASH
GLENDALE
PHOENIX
ARIZONA CANAL
SCOTTSDALE
MESA
TEMPE
GILBERT
CHANDLER
QUEEN CREEK
SALT RIVER
GILA RIVER
WATERMAN WASH

US 60
I-10
I-17

AC AD AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR AS AT AA

N

10 5 0 10 Miles

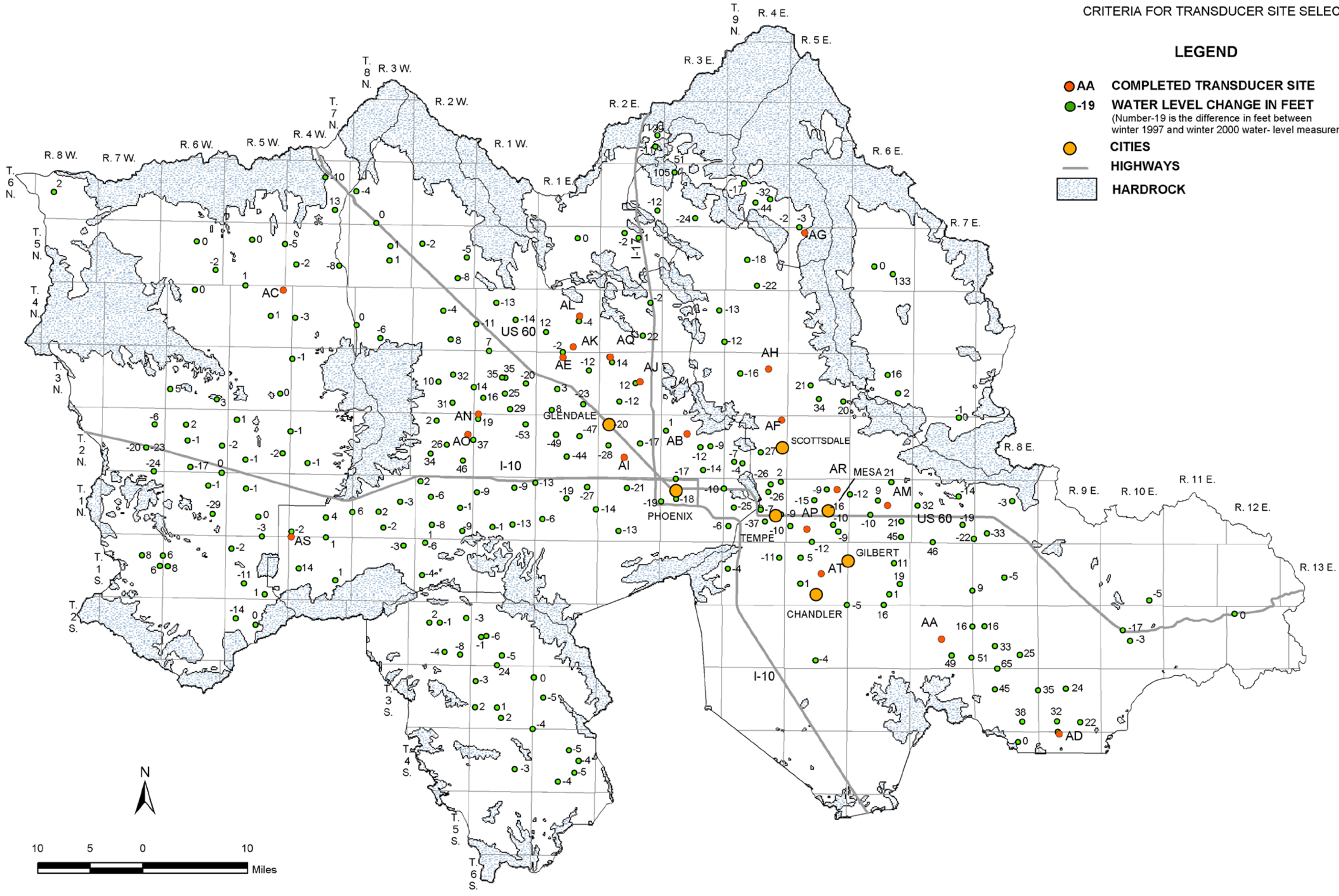
MAP OF PHOENIX AMA ILLUSTRATING RIVER AND STREAM COURSES

PLATE 6

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

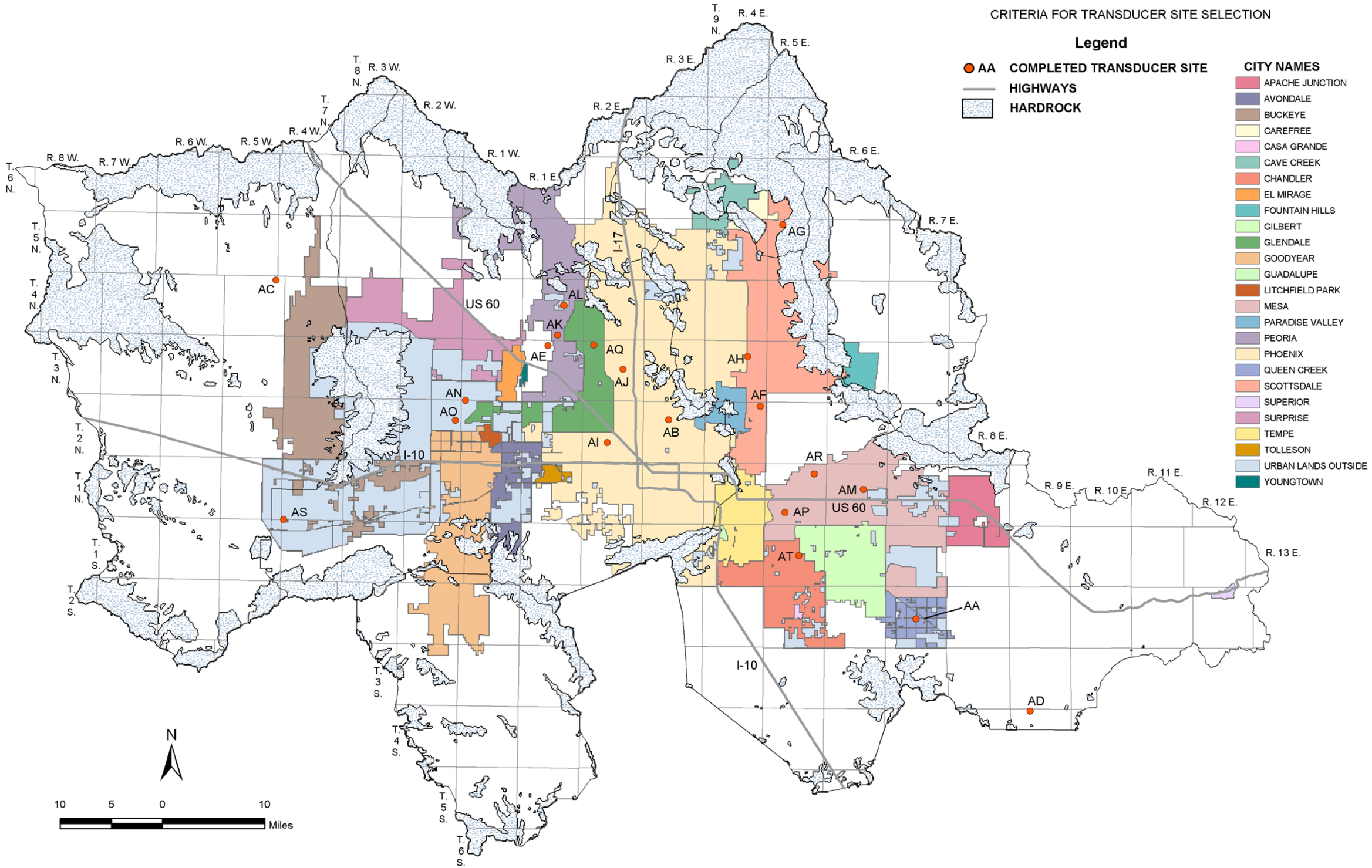
- AA — COMPLETED TRANSDUCER SITE
- -19 — WATER LEVEL CHANGE IN FEET (Number-19 is the difference in feet between winter 1997 and winter 2000 water- level measurements)
- CITIES
- HIGHWAYS
- HARDROCK



MAP OF PHOENIX AMA ILLUSTRATING WATER LEVEL ELEVATION CHANGES (IN FEET) FROM 1997 TO 2002

PLATE 7

CRITERIA FOR TRANSDUCER SITE SELECTION



MAP OF PHOENIX AMA ILLUSTRATING POLITICAL BOUNDARIES

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AC COMPLETED TRANSDUCER SITE
- SUBSIDENCE ZONES
- CITIES
- HIGHWAYS
- HARDROCK

T. 9 N. R. 4 E. R. 5 E. R. 3 E. R. 2 E. R. 6 E. R. 7 E. R. 8 E. R. 9 E. R. 10 E. R. 11 E. R. 12 E. R. 13 E.
T. 8 N. R. 3 W. R. 2 W. R. 1 W. R. 1 E.
T. 7 N. R. 4 W.
T. 6 N. R. 8 W. R. 7 W. R. 6 W. R. 5 W.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
T. 3 S.
T. 4 S.
T. 5 S.
T. 6 S.

US 60
I-17
I-10
US 60

AC AL AK AQ AE AJ AN AO AI AH AG AF AB AR AM AP AT AS AA AD

GLENDALE
PHOENIX
SCOTTSDALE
MESA
TEMPE
GILBERT
CHANDLER

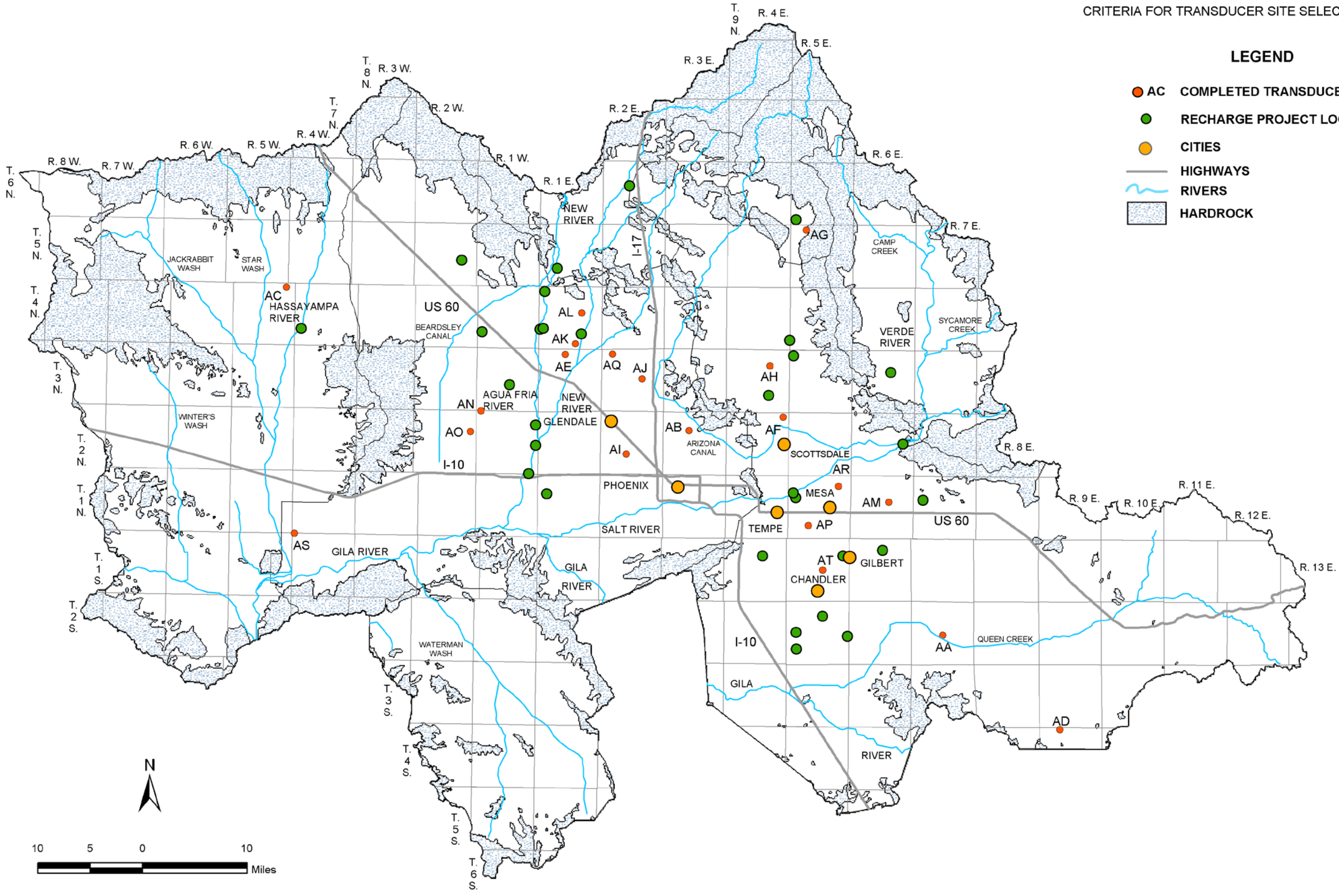
N

10 5 0 10 Miles

MAP OF PHOENIX AMA ILLUSTRATING SUBSIDENCE ZONES

PLATE 9

CRITERIA FOR TRANSDUCER SITE SELECTION



MAP OF PHOENIX AMA ILLUSTRATING RECHARGE PROJECT LOCATIONS

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AA COMPLETED TRANSDUCER
- CITIES
- HIGHWAYS
- HARDROCK

IRRIGATION COMPANY

- 100 Coop
- 200 Coop
- Adaman Irrigation Water Delivery District #36
- Arabian Farms Association
- Arcadia Water Company
- Arlington Canal Company
- Buckeye Water Conservation and Drainage District
- Chandler Heights Citrus Irrigation District
- Citrus Glen Owners Association Inc.
- Citrus Heights Ranch
- Clearwater Farms Unit I
- Clearwater Farms Unit II
- Country Farms Irrigation & Management Co.
- Estrella Meadow Water Coop
- Hassayampa Water Coop
- Maricopa Water District
- New Magma Irrigation and Drainage District
- Olive Avenue Homeowners Association
- Orangewood Farms
- Peninsula Ditch and Irrigation District
- Queen Creek Irrigation District
- Queen Creek Irrigation Water Delivery District
- Queen Creek Suburban Ranches
- Ranchos Jardines Irrigation Delivery District
- Roosevelt Irrigation District
- Roosevelt Water Conservation District
- Saint Johns Irrigation District
- Salt River Valley Water Users Association
- San Tan Irrigation District
- Suburban Irrigation District
- Sun Valley Farms Coop III (Inactive 2001)
- Sun Valley Farms Unit II
- Sun Valley Farms Unit IV
- Sun Valley Farms Unit VII
- Sunburst Farms Irrigation District
- Tonopah Irrigation District
- Western Meadows Irrigation District

T. 9 N. T. 8 N. T. 7 N. T. 6 N. T. 5 N. T. 4 N. T. 3 N. T. 2 N. T. 1 N. T. 1 S. T. 2 S. T. 3 S. T. 4 S. T. 5 S. T. 6 S.

R. 8 W. R. 7 W. R. 6 W. R. 5 W. R. 4 W. R. 3 W. R. 2 W. R. 1 W. R. 1 E. R. 2 E. R. 3 E. R. 4 E. R. 5 E. R. 6 E. R. 7 E. R. 8 E. R. 9 E. R. 10 E. R. 11 E. R. 12 E. R. 13 E.

I-17 I-10 US 60

AA AC AD AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR AS AT AB

GLENDALE PHOENIX SCOTTSDALE MESA TEMPE GILBERT CHANDLER

N

10 5 0 10 Miles

MAP OF PHOENIX AMA ILLUSTRATING IRRIGATION COMPANIES

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AA — COMPLETED TRANSDUCER SITE
- EPA SUPERFUND SITES
- WQARF SITES
- CITIES
- HIGHWAYS
- HARDROCK

T. 9 N.
T. 8 N.
T. 7 N.
T. 6 N.
T. 5 N.
T. 4 N.
T. 3 N.
T. 2 N.
T. 1 N.
T. 1 S.
T. 2 S.
T. 3 S.
T. 4 S.
T. 5 S.
T. 6 S.

R. 8 W. R. 7 W. R. 6 W. R. 5 W. R. 4 W. R. 3 W. R. 2 W. R. 1 W. R. 1 E. R. 2 E. R. 3 E. R. 4 E. R. 5 E. R. 6 E. R. 7 E. R. 8 E. R. 9 E. R. 10 E. R. 11 E. R. 12 E. R. 13 E.

AA AB AC AD AE AF AG AH AI AJ AK AL AM AN AO AP AQ AR AS AT

GLENDALE PHOENIX SCOTTSDALE MESA TEMPE GILBERT CHANDLER

US 60 I-10 I-17

N

10 5 0 10 Miles

MAP OF PHOENIX AMA ILLUSTRATING EPA SUPERFUND AND WQARF SITES

PLATE 12

CRITERIA FOR TRANSDUCER SITE SELECTION

LEGEND

- AC — COMPLETED TRANSDUCER SITE
- 389 — SPECIFIC CONDUCTANCE VALUES (Number indicates MicroSiemans per centimeters at 25°c) (µS/cm)
- CITIES
- HIGHWAYS
- HARDROCK

T. 6 N. T. 5 N. T. 4 N. T. 3 N. T. 2 N. T. 1 N. T. 1 S. T. 2 S. T. 3 S. T. 4 S. T. 5 S. T. 6 S.

R. 8 W. R. 7 W. R. 6 W. R. 5 W. R. 4 W. R. 3 W. R. 2 W. R. 1 W. R. 1 E. R. 2 E. R. 3 E. R. 4 E. R. 5 E. R. 6 E. R. 7 E. R. 8 E. R. 9 E. R. 10 E. R. 11 E. R. 12 E. R. 13 E.

T. 8 N. T. 7 N. T. 9 N.

I-17 I-10 US 60 US 60 I 10

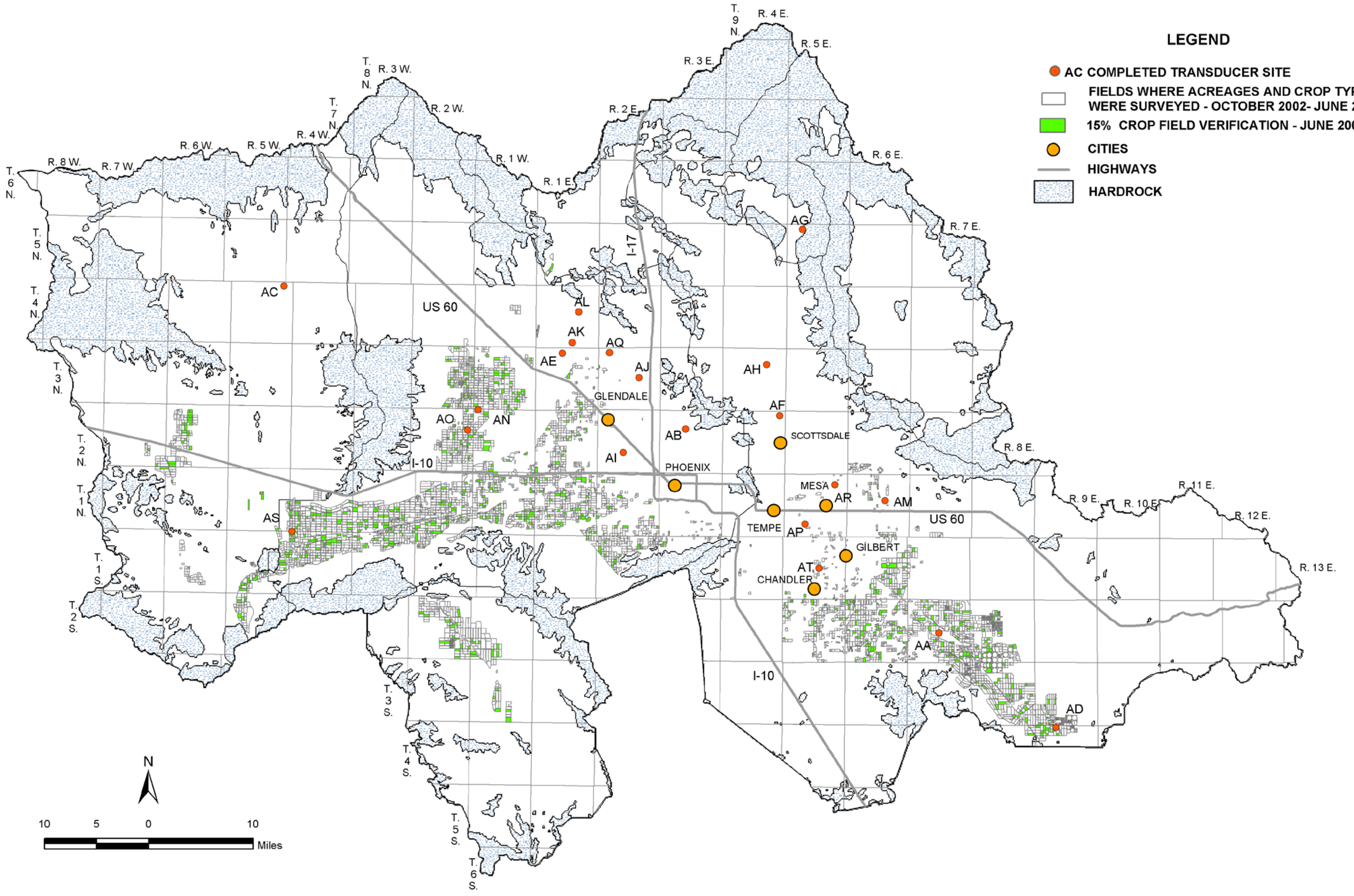
PHOENIX SCOTTSDALE TEMPE MESA GILBERT CHANDLER GLENDALE

AC 389 1097 371 400 456 AG AL 536 409 485 AK 934 406 676 541 AE AQ AJ 457 AH 385 391 469 425 AN 3270 589 1252 AO 1031 577 1150 AI AB AF 1432 1476 1225 1013 1366 1062 AM 1540 2680 4620 3170 400 AS 5110 5490 1547 AP 2520 2330 2000 1740 1622 1834 2860 AT 2070 2140 1551 2160 AA 4350 1983 1785 AD

N

10 5 0 10 Miles

MAP OF PHOENIX AMA ILLUSTRATING SPECIFIC CONDUCTANCE VALUES IN WELLS SAMPLED IN 2002-2003



MAP OF PHOENIX AMA ILLUSTRATING LOCATIONS OF FIELDS WHERE CROPS WERE SURVEYED - JUNE 2003